Landscape as a dynamic system

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The source of direct geographic information is variety of observed phenomena. This variety expands as the technical means of measurement develop but can never be exhaustible. Moreover, newest technical means can lead to new discoveries. Continual representation of natural phenomena with fixed spatial resolution can be derived only through multispectral remote sensing data. Field observations are inevitably discrete. The outstanding role in perception of landscape belongs to vision which continually scans space during field routes or from constant viewpoints. Human brainwork transforming this information compares observations with a priori models and patterns. In fact, human brain works in pattern recognition way. In case reality is provably inadequate to model the scientist searches for better model. New model is developed through mechanisms that validate contradictions. Usually new model are characterized by better generality. Independent of research object the scientist is always limited within existing models and conceptions learned during education.

Like all natural and social sciences geography until end of XX century based on equilibrium process model, equilibrium thermodynamics with principles of gradualism and actualism, nature laws permanence and process reversibility. Severe reality of XX century last quarter significantly decreased the area of this model use. It was developed that thermodynamic model of non-equilibrium and non-stationary processes is more adequate to reality. Equilibrium model became an ideal, limit case (Nicolis, Prigogin, 1979). The fractal model of nature geometry which is closely connected to thermodynamic one was also developed during this period (Mandelbrot, 2002). As an addition to thermodynamics the following models were developed. Synergetic model, which bases on systems of non-linear equations and model of local interactions determined by general rules (order parameters) (Haken, 1993). This new conception synthesis in not final stage of science development. Science actively searches for integration ways of thermodynamics, information theory which can connect structure of system with its functioning (Hazen, 2000). Among all visible differences in these approaches the general system of conceptions appears which can give the basis of more definite understanding of nature evolution and its various occurrences. Although the search of new ideas was stimulated by biology and economy, but it also develops in geology, especially geodynamics.

The general basis of this model is conception of dynamic system (DS) – an object of any nature which state changes in time according to dynamic laws. Term DS is a mean of idealization. Object is being separated from its environment and do not settle all reality.

Let us imagine an ensemble of phenomena which are connected in varying degree. Each of them is characterized by autochthonous dynamics because of feedback. Their fundamental feature is non-linearity i.e. dependence from own state. Dynamics and evolution of such a system is supported by energy and matter flow (open system), which are partly dissipated by system. This system inevitably has hierarchy, has a number of local equilibrium areas, chaotic dynamics succeeded by quasi-harmonic oscillations. The system has an ability of self-development as soon as it searches for local equilibriums with environment.

The land cover of Earth which is given through observations in the given moment, can be presented as projection of numerous realized trajectories of this DS. This projection

reflects almost all features of system. Is should be a fractal (it is proved), should be hierarchically organized, should have areas with almost stochastic spatial structure and should have various scale local equilibrium areas with real borders – bifurcation points. DS model allows by the data existence of emergence properties and, accordingly, presence of integrity elements. Due to non-linearity strong interactions and resonance effects can emerge between various phenomena in wide range of spatial-temporary oscillation scale.

This conception of geographical envelope and landscape as its structural part gives basis to synthesize existing spatial-temporary models. The DS model integrates through this point of view the chorological conception and idea of common geographical process. Its basis can be found in theoretical research of Victor Sochava. He developed perception of invariance, geomere and geochore relation.

DS research claims for some change in science methodology, first – the development of close interaction of models of DS behavior. It is very important to have imaginative maximally critical look of naturalist and to analyze measurements which are directed to search the order parameters in phenomena relations in spatial-temporal scale.

The research of landscape from the point of view of DS needs permanent extending of observed features and phenomena, active use of new measure systems and measure complexes which provide maximum information about spatial variation. In Landscape science, full set of measurements made from space should be included in research. We also should not forget analysis of connection between cloud systems and land cover, magnetometry and gravity measurement. Objects of special interest are various scale faults of earth crust as soon as these are areas of non-stationary and a priori active state. Another actual problem of landscape science is forming of meso-climate as synergetic effect of interaction between ground layer of atmosphere and land cover properties and as potential generator of large scale fluctuations of atmospheric processes.

In the given report the basic conception of DS is considered as well as approaches to its research. The properties of geographical envelope and landscape are demonstrated that follow as a result of general DS general idea. Various approaches to its research considered at the basis of remote sensing information and field observations.

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References

Nicolis G., Prigogin I. (1977) Self-organization in Nonequilibrium System. Wiley, New York.

Mandelbrot B. (1982)The Fractal Geometry of Nature, *W.H. Freeman & Co.*

Khazen A. (1993) Maximum entropy production as a motive force of progressive biological evolution. *Biophysics, V. 38, №3, pp. 537-565*

Haken H. (1993) Advanced Synergetics: Instability Hierarchies of Self-Organizing Systems and Devices. *New York: Springer-Verlag.*